Trapping and Coded Wire Tagging of Wild Coho Salmon Smolts in the Campbell River (Semiahmoo Bay), 1982

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ABSTRACT

Schubert, N.D. 1983. Trapping and coded wire tagging of wild coho salmon smolts in the Campbell River (Semiahmoo Bay), 1982. Can. MS Rep. Fish. Aquat. Sci. 1738: vii + 24p.

Coho salmon smolts from the Campbell River were captured and coded wire tagged during the spring of 1982. A total of 16,138 coho smolts were captured, of which 15,637 were released with tags (code 02 22 62). The smolts averaged 112.9 mm in length and 13.3 g in weight. The coho smolt migration had an apparant duration of six weeks, peaking in mid May.

Résumé

Schubert, N.D. 1983. Trapping and coded wire tagging of wild coho salmon smolts in the Campbell River (Semiahmoo Bay), 1982. Can. MS Rep. Fish. Aquat. Sci. 1738: vii + 24p.

Au cours du printemps de 1982, on a capturé de jeunes saumons cohos de la rivière Campbell et on leur a fixé une étiquette métallique codée. Un total de 16,138 saumoneaux cohos ont été capturés, dont 15,637 ont été libérés, munis d'une étiquette (code 02 22 62). Les saumoneaux avaient en moyenne une longueur de 112.9 mm et un poids de 13.3 g. La migration des jeunes saumons cohos avait une durée apparente de six semaines, atteignant un maximum à la mi-mai.

INTRODUCTION

A coho smolt coded wire tagging (CWT) study was conducted in the Campbell River, a small stream flowing into Semiahmoo Bay near White Rock, B.C., during the spring of 1982. This was one of several programs recently initiated by the Fraser River, Northern B.C. and Yukon Division to determine the exploitation rate, catch distribution and survival rate of specific coho stocks (Argue and Armstrong 1977, Schubert 1982, Fedorenko and Cook 1982, Schubert 1982 MS).

The Campbell River is one of three small coho streams which drain the lowland agricultural area southeast of the Fraser River outlet. The Campbell River was selected for study primarily for the excellent prospect of ongoing assessment. A local community group, the Semiahmoo Fish and Game Club (SFGC), owns property on the stream and since 1980 has operated a spawner enumeration fence under the auspices of the Salmonid Enhancement Program. The purpose of this facility was to provide more accurate stock abundance informamation prior to enhancement in the system.

The objectives of the 1982 tagging program were as follows: First, to capture and coded wire tag sufficient numbers of coho smolts to allow an assessment of the smolt to adult survival, exploitation rate and catch distribution. Second, to conduct a preliminary assessment of smolt species composition, migratory pattern, and size and age composition. Third, to involve SFGC members in the operation and maintenance of the fence trap in a mutual assessment of their ability to conduct similar programs in the future. And finally, to conduct an opportunistic assessment of the degree of residualism resulting from a prior release of cultured steelhead trout smolts.

This report summarizes the results of the 1982 program, including daily catch by species, migratory timing, numbers of coho smolts released with tags, and coho age and length compositions. Trout age and length data are on file at the Fish and Wildlife Branch, Abbotsford B.C.

WATERSHED DESCRIPTION AND SALMONID RESOURCE

The Campbell River flows in a westerly direction for approximately 26 km before entering Semiahmoo Bay, 1.5 km north of the Canada - United States international boundary (Figure 1). The system drains approximately 85 km^2 of intensively developed coastal agricultural land. The stream typically flows in a shaded meandering channel; tidal influence extends up to 4 km upstream, and the upper reaches tend to be marshy.

The stream hydrograph reflects seasonal precipitation patterns (Appendix 6). Maximum flows occur during late fall and winter, with an extreme flow of 14.2 cubic meters per second recorded on December 23, 1964. Minimum flows occur between July and September, with an extreme flow of 0 cms recorded on September 12, 1964. The mean annual daily discharge, based on 1962 and 1963 data, was 0.938 cms.

The Campbell River supports three species of Pacific salmon (coho, chum and chinook) (Appendix 5) as well as steelhead and cutthroat trout. Coho salmon escapements averaged approximately 1,400 during the period 1947 to 1982, with a recent five year average of approximately 2100 spawners (Appendix 5). Chum escapements averaged 260 over the period of record, with current escapements near that level. A small run of chinook salmon (average escapement of 50) has also colonized the system since 1978. Coded wire tag recoveries from this run indicate that a substantial component may stray from Puget Sound hatcheries

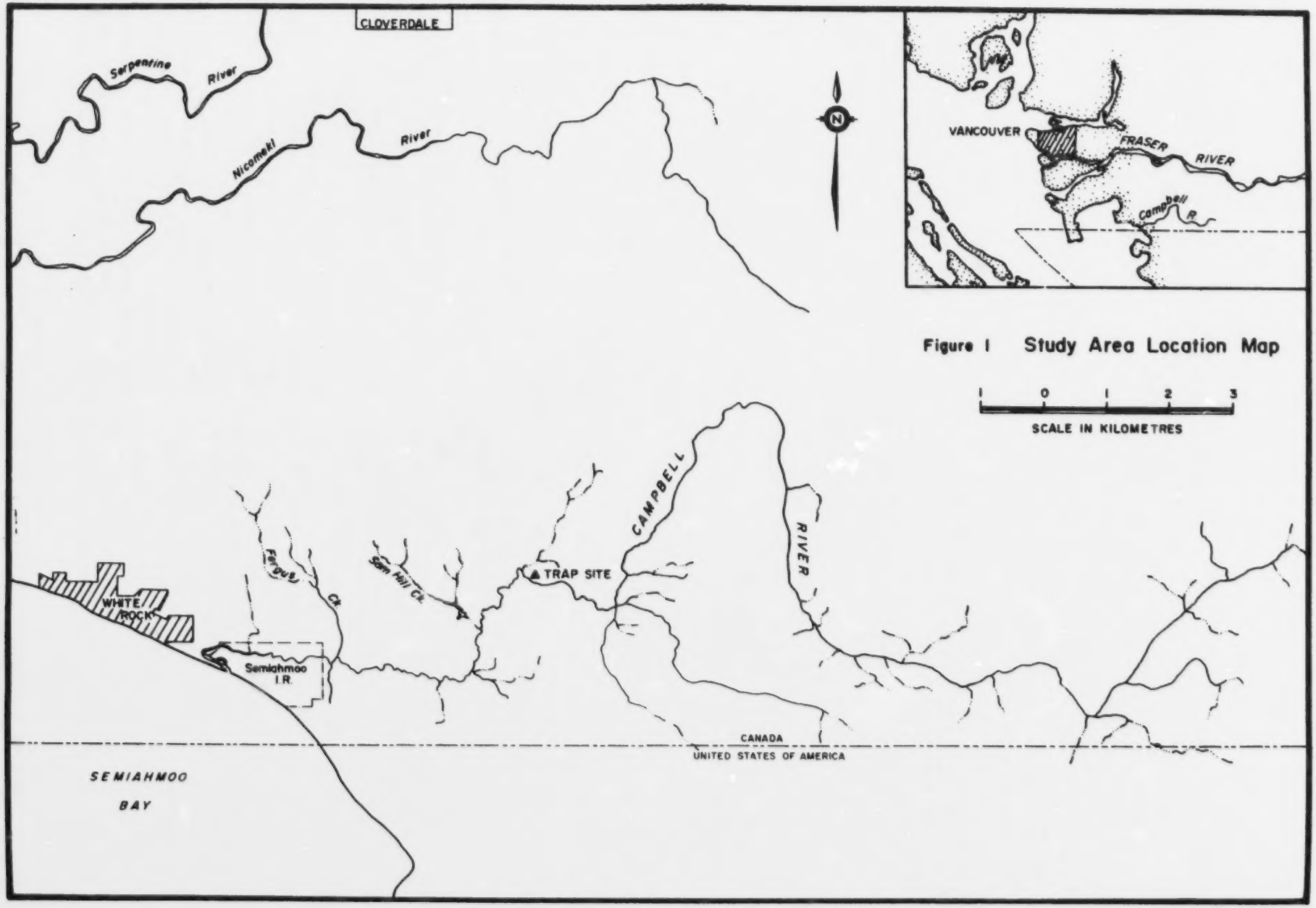

Figure 1 Study Area Location Map

(J. Kambeitz, pers. comm.). Steelhead and cutthroat trout escapements total less than 200.

Spawning distributions, timing and age, length and sex compositions of Campbell River coho and chum salmon were described by Schubert (1982). Spawning generally occurs between late October and mid January in an 8 km section of the middle reaches of the mainstem as well as in the lower reaches of Sam Hill and Fergus Creeks and an unnamed creek located approximately 1.2 km upstream. Chum salmon return at age three or four; coho salmon are primarily three year olds, although a significant number of four year olds return in some years.

METHODS

FENCE TRAPPING

A fence trap similar in principle to that described by Armstrong and Argue (1977) was installed in the Campbell River at the SFGC site, approximately 7.5 km upstream, on April 27, 1982. The fence consisted of a series of 0.8 m by 2.4 m wooden frame panels covered with a 6mm galvanized mesh screening. These panels were installed in a converging 'W' pattern, diverting all emigrant fish into two sluice troughs which dropped into two respective plywood holding boxes. A 'W' design was selected rather than the traditional 'V' to ensure that the greatest hydraulic pressure would occur over the short concrete apron of the adult trap rather than over the stream bed. The stream substrate was composed of shifting sand/pebble, therefore the standard 'V' trap was felt to be too subject to undermining at higher discharges.

The fence trap catches were enumerated each morning and afternoon (once daily on weekends, usually by SFGC members) and all coho smolts were transferred to nearby plywood holding boxes where they were held for tagging and sampling. Coho and chum fry were enumerated prior to release; however these catch totals may not accurately reflect the daily emigration since the 6 mm mesh on the holding box was insufficient to fully restrict passage of the smaller individuals. Trout were enumerated by species and recorded as smolts or presmolts. Smolts were defined as those fish with a silver coloration and with a fork length generally greater than 11 cm. Presmolts were defined as those fish with distinct parr marks and with a fork length less than 11 cm. All wild trout were transferred to nearby holding boxes where they were held for triweekly sampling by Fish and Wildlife Branch personnel. Recaptures from the 4,000 steelhead juveniles planted approximately 2 km above the fence site on April 30 were identified by the adipose clip and recorded as smolts or presmolts prior to release below the fence. All other species were identified and released below the fence.

Water temperatures, air temperatures and water levels were recorded at least once daily. All temperatures were measured with a pocket thermometer, and water levels were measured on a staff gauge installed at the site.

Trap Efficiency

The fence trap capture efficiency for coho smolts was assessed on two occasions by releasing 50 coho smolts marked with adipose and caudal clips at a site approximately 50 m upstream from the fence trap. All subsequent captures were examined for a caudal clip during the tagging process rather than during the daily enumeration procedures in order to avoid excessive stress from individual handling and because the inevitable escapees from such a procedure would compromise the data. Recaptures were noted and released.

The first group of coho, released on May 21, was marked by removing the extreme distal portion of the lower lobe of the caudal fin. The second

group was marked by removing the distal portion of the upper lobe and was released on June 1.

TAGGING PROCEDURE

The coded wire tagging equipment and machine maintenance procedures used during this study were similar to those described by Armstrong and Argue (1977). Tagging operations were conducted twice per week. On each tagging day, the tag implant location was checked for each tag lot by bisecting the skull of a tagged coho with a scalpel along the median plane. If the tag was not in the preferred position in the cartilaginous wedge (the chondrocranium), the implant depth was adjusted and the procdure repeated until tag placement was correct. Following this check the remaining smolts were tagged.

During the tagging operation, the fish were anesthetized using a Tricaine Methane Sulfonate (TMS) solution of 7.5 g per liter of water which was further diluted, as conditions dictated, in a 7.5 liter plastic basin. The smolts were graded into two size classes, based on a 95 - 100 mm fork length cut off between groups, and separate nose molds and needle penetration depths were used for each group to ensure proper tag location. Coho smolts of all sizes were tagged; however, any diseased or damaged fish were noted and excluded from tagging. The graded smolts were then marked by adipose fin removal, tagged, and passed through the quality control device (QCD) to ensure the tag was present. A random sample of 100 to 500 smolts was removed from the recovery bucket throughout each tagging operation and retained for forty-eight hour mortality and tag retention assessments. Any smolts found without pins were retagged, and the tag lot figures were adjusted to reflect the number released with tags. All other tagged smolts were allowed to recover from the anesthetic before release below the fence.

All 1982 Campbell River coho smolts were tagged with the same code: 02 22 62.

BIOLOGICAL SAMPLING

Coho smolt sampling was carried out twice weekly in order to assess changes in smolt age and size with time. Fifty smolts were removed randomly from the daily catch and anesthetized in a TMS solution, as above. A scale smear was removed with a scalpel from the "preferred region", as defined by Clutter and Whitesel (1956), and the nose-fork length was measured to the nearest millimeter. A mean wet weight was derived from a subsample of at least 25 smolts weighed in aggregate (±0.1g) on an Ohaus triple beam balance.

Disease Monitoring

An opaque clouding of the eye, commonly termed "fog-eye", was prevalent during 1982. Samples were analyzed by G.E. Hoskins of the Fisheries Research Branch, and a brief assessment of the relationship between "fog-eye" and holding time was conducted on May 20. Subsamples of 200 smolts from each of three consecutive days catches were held for periods of 16, 40 and 72 hours, respectively, prior to visual examination. The condition of each fish was recorded: no fog-eye, slight-one eye, slight-two eyes, severe-one eye or severe-two eyes.

RESULTS AND DISCUSSION

FENCE TRAPPING RESULTS

Catches

Daily fence trap catches are reported in Appendix 1. The total catch of coho smolts, coho fry, chinook smolts and chum fry was 16,138, 7,869, 229 and 267, respectively. Although no chinook were noted during the daily enumeration, several were identified by scale patterns in the biweekly sample. Daily catches

reported in Appendix 1, therefore, were adjusted accordingly.

The catch of wild steelhead smolts and presmolts, and wild cutthroat smolts and presmolts totalled 1012, 114, 232 and 22 respectively. Only 35.8% (N=1433) of the 4000 hatchery steelhead released on April 30 were recaptured during the study period. It remains unclear what proportion of the remaining fish were lost to predation, residualized in the system or escaped the fence trap; however, even when the lowest observed capture efficiency of 72% is used (discussed later), in excess of 50% of the planted smolts cannot be accounted for. In view of potential adverse impacts on wild stocks if a significant proportion of these fish remained in the stream, a thorough reexamination of the steelhead smolt outplant strategy is indicated.

A number of spawned out adults were also captured: 14 cutthroat and 5 steelhead kelt carcasses were removed from the fence. One steelhead kelt captured on June 20 was a tagged (code 54 62 2) 1979 brood fish reared at Bellingham Hatchery and released into Samish River in April 1980.

Other species captured, in descending order of abundance, were: prickly sculpins (**Cottus asper**), crayfish (**Pacifastacus sp.**), western brook lampreys (**Lampetra richardsoni**), Pacific lampreys (**Entosperus tridentatus**), three spine stickleback (**Gasteroteus aculeatus**), lamprey amocoetes, river lamprey (**Lampetra ayresi**) and longnose suckers (**Catostomus catostomus**).

Flows were generally low throughout the 1982 study; however, trap integrity was compromised on May 19 and June 9 when sandbag deterioration caused short sections of the trap to undermine. Although the undermining was minor in extent and was repaired immediately, catches on those dates and the totals reported above probably underestimate the actual emigration during the study period.

Trap Efficiency

The fence trap capture efficiency for coho smolts was estimated on two occasions encompassing the periods May 21 to June 22 and June 1 to June 22 respectively. The first test was initiated on May 21 by releasing above the fence 50 coho smolts marked with a lower caudal clip. A total of 49 were recaptured, for an overall efficiency of 98%. Forty-eight of those fish were recaptured by May 31, with the last fish recaptured on June 10.

A second group of 50 coho marked with an upper caudal clip were released on June 1. A total of 36 were recaptured, for an overall efficiency of 72%. Only 28 (56%) of those fish were recaptured by June 7, with 30 (60%) recaptured by June 9, 34 (68%) by June 11, and 36 (72%) recaptured by June 18.

Two mechanisms are proposed to explain the large difference between the two tests: first, the trap partially undermined on the night of June 8-9, reducing the coho catch during that period to zero. Although fence undermining can significantly reduce daily capture efficiencies, it is unlikely, in view of the small daily catch before and after June 9 and the low, constant flows during that period, that all 14 marks were lost at that time. Second, the rate of recapture of the later group was much slower, with only 28 recaptured in the first week compared to 48 in the earlier test. This suggests that the program may have terminated before all marks had emigrated and that the real efficiency was somewhat higher than that recorded by the second test.

It can be concluded from the above data that the Campbell River fence trap was extremely efficient under normal operating conditions, and that the apparent catches on May 19 and June 9 may significantly underestimate the actual numbers which

emigrated on those days; however, accurate estimates of the numbers lost during the two washouts cannot be derived from the above data. More precise estimates of overall trap efficiency require daily releases of a fixed proportion of the catch throughout the trapping period. It is emphasized, however, that those figures still represent estimates of minimum capture efficiency. It remains unclear if observed losses result from residualism, predation, handling mortality or from undetected fence holes.

Limitation of Fence Trap Data

Caution is urged in the interpretation of the 1982 catch data. The 1982 program was designed primarily to capture sufficient numbers of coho smolts for tagging, and was not intended to assess total smolt production for either the system as a whole or for that part upstream from the fence site. Several factors suggest that the fence catches underestimate both of the above. First, the trap site location excludes approximately 7.5 km of potential rearing habitat in the lower river, an area where previous studies have reported excellent coho growth (Ross Peterson, pers. comm.). Second, the April 28 installation date precluded assessment of any smolts which had reared and overwintered in the upstream area but which had emigrated prior to that date. Other studies (Salo and Bayliff 1958, Anderson 1978, de Hrussoczy-Wirth 1979, Shapovalov and Taft 1954) have reported significant emigrations of salmonid smolts in February or earlier. And finally, any individuals which reared in the upstream area but which emigrated during the fall or winter, either to overwintering habitat in the lower river or out of the system entirely, would have been excluded from enumeration. Shapovalov and Taft (1954) report such movements are common in California trout. In view of the above, 1982 catch totals may significantly underestimate the annual smolt yield.

Migration Timing

Coho Smolts : The coho smolt emigration was well underway when the trap was installed on April 28 and continued sporadically through late June. The bulk of the emigration occurred during the month of May with the 50% migration, as defined by the date of 50% catch, occurring on May 13 (Table 1). This pattern is

Table 1. Summary of 1982 Campbell River salmonid emigration peaks.

Species	50% Peak	Daily Maxima		
		Date	Number	% Total
Coho Smolts	May 13	May 19	1,187	7.4%
Chum Fry	May 19	May 18	26	9.7%
*Chinoook Smolts	June 2	May 31	28	12.2%
Steelhead Smolts, wild	May 14	May 15	129	13.0%
Steelhead Smolts, hatchery	May 10	May 3	145	10.0%
Cutthroat Smolts	May 20	May 19	16	6.9%

*Estimated from scale sample data. All chinook were misidentified as coho in the field.

similar to that observed in other B.C. streams (Schubert 1982; Fedorenko and Cook 1982).

The pattern of migration was not strongly correlated with either temperature or stream level (Figure 2).

Chum Fry : Small numbers of chum fry were captured throughout the program with the 50% migration occurring on May 19 (Table 1). This pattern is considerably later than the mid to late April migratory peak recorded in the Fraser River at Mission (Bailey MS); however, the observed peak in the Campbell River is biased by the late start of the capture period. The main migration may have occured prior to program implementation.

Trout Smolts : The 50% migration peak of wild trout smolts occurred in mid-May, with the steelhead peak preceding the cutthroat peak by six days (Table 1). The timing of hatchery reared steelhead was earlier, with the 50% peak occurring by May 10. The first hatchery smolt was captured on May 1, one day after the April 30 release, and catches continued sporadically until the program terminated.

Chinook Smolts : Chinook smolts were captured only during the final three weeks of the program. The greatest number were captured during the week of June 4.

Periodicity : The trap was monitored twice daily (at approximately 0900 and 1600 h) on twenty-one occasions in order to quantify diurnal aspects of the migration. On the days monitored, the diurnal component of the diel migration averaged 11.8% for coho smolts, 6.3% for chum fry, 3.2% for cultured steelhead trout smolts, 8.3% for wild steelhead trout smolts and 1.0% for wild cutthroat trout smolts (Appendix 1a). Diurnal movements were also observed in the Salmon River (Schubert 1982) and in Salwein Creek (Schubert 1984), although they constitutted a much larger proportion of the total emigration in those systems (49.6% and 36.0% of the coho smolt catch in Salmon River and Salwein Creek respectively).

No clear correlation was noted between diurnal migration and water temperature; however, the onset of coho smolts diurnal migration (the only species where numbers were sufficient to indicate a trend), was associated with an increase of water temperatures above 10.5° C for a number of days (Appendices 1 and 4) and continued through the period of peak migration.

A number of researchers (Osterdahl 1969, Solomon 1978) have associated diurnal migrations in Atlantic salmon smolts with an increase in water temperatures above a certain critical threshold (generally 10°C). Thorpe and Morgan (1978) cited data which suggests that, when water temperature rise beyond this critical level, a rise in oxygen demand will result in reduced activity and an associated increased probability of downstream movement. A similar mechanism may act in Pacific salmonids.

COHO TAGGING RESULTS

A total of 15,923 coho smolts were adipose clipped and coded wire tagged during 1982 (Appendix 2a). When adjustments were made for delayed tag loss and mortality, the number released with tags was 15,637; however, based on biological sample results, an estimated 163 chinook smolts were misidentified and tagged as coho. Delayed tag loss averaged an unusually high 3.88% (N=2,346) with a daily tag lot range of 0% to 9.84%. Holding and post-tagging mortality were negligible.

The incidence of diseased or damaged coho smolts encountered during the program was 11.1% (Appendix 2b). By far the most prevalent condition was an opaque clouding of the eye lens termed 'fog-eye' (7.97%), a re-

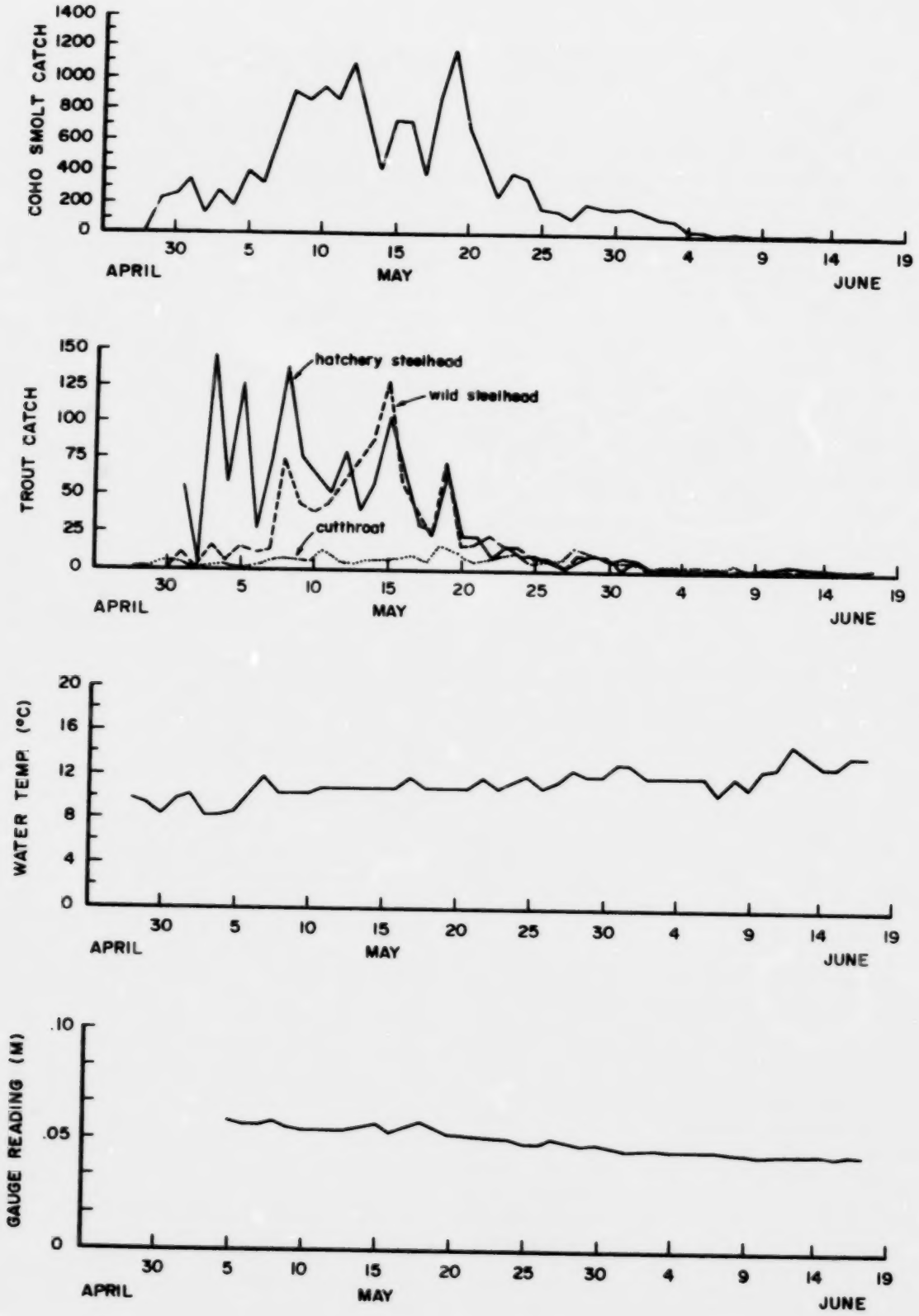

Figure 2 Emigration of Little Campbell River coho and trout smolts in relation to date, water temperature and discharge.

versible condition believed to be associated with handling stress and low dissolved oxygen levels (G. Hoskins, pers. comm.). Also present was an infestation of flukes of the genus **Neascus** (1.14%), an innocuous parasite which apparently disappears when the fish enter salt water, and exophthalmia (0.73%), a protrusion of the eyes which an autopsy confirmed was a result of an accumulation of unicellular flagellates of genus **Cryptobia** (G. Hoskins, pers. comm). The incidence of naturally missing adipose fins was 0.012% (N=2). It should be noted however, that the term 'naturally missing adipose' denotes a deformed fin which might be mistaken for an incomplete clip in subsequent dead pitches. No individuals were noted with completely missing adipose fins.

BIOLOGICAL SAMPLING

Coho Smolts

Age : Coho emigrated from the Campbell River almost entirely as yearling or age 1+ smolts with two year old or age 2+ smolts comprising the remaining 0.1% of the run (Table 2). The number of age 2+ smolts captured was insufficient to indicate any differences in timing by age class.

Length and Weight : The fork length of Campbell River coho smolts averaged 112.9 mm in 1982 (Table 2), with age 1+ smolts (114.1 mm) larger than age 2+ smolts (95.0 mm); however, the age 2+ sample was too small to provide a statistically significant comparison. The coho smolt mean length was greatest at the start of the trapping period and generally decreased through the remainder of the run (Figure 3). A similar pattern was observed in the Salmon River (Schubert 1982).

Mean wet weights were derived by calculating a logarithmic functional regression of weight on length from the April 30 to May 28 bi-weekly sample data rather than by weighting the weight sample data in order to avoid the mixed species problem in the later aggregate weight samples. The following regression was calculated:

$$\ln \text{Weight (g)} = -6.26 + 1.87 \ln \text{length (mm)}$$

$$r = 0.86$$

The overall mean weight of the 1982 smolts was 13.3 g, with weights of 13.6 g and 9.6 g calculated for ages 1+ and 2+ respectively.

Table 2. 1982 mean fork lengths (weighted) and wet weights of Campbell River coho and chinook smolts, by age class (data from Appendix 3).

Species	Age	Percent Composition	Mean Fork Length in mm (N)	*Mean Wet Weight(g)	Number per kilogram
Coho	1+	0.1%	114.1 (412)	13.6	73.5
	2+	99.9%	95.0 (1)	9.6	104.2
	Combined	100.0%	112.9 (532)	13.3	75.2
Chinook	0+	100.0%	86.1 (63)	-	-

* calculated from regression.

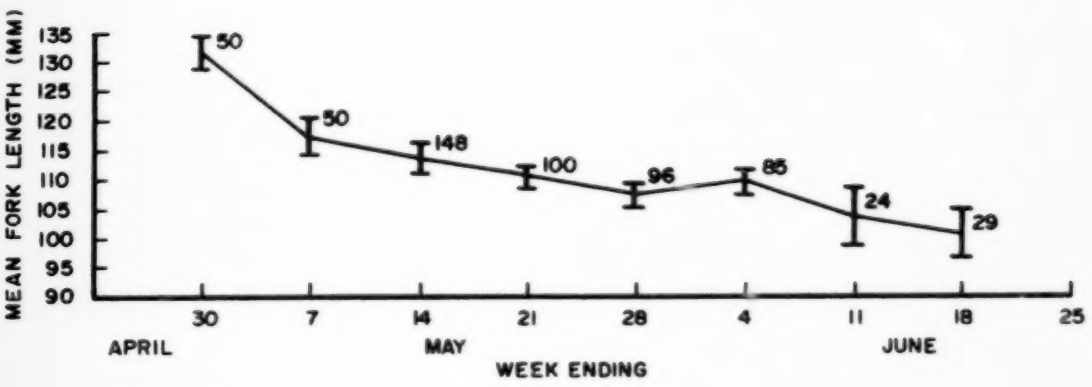

Figure 3 Weekly summary of coho smolt mean fork lengths (numerals represent sample sizes; vertical bars are 95% confidence limits)

The smolt sizes observed in the Campbell River were considerably larger than those reported in most other coastal streams. For example, fork lengths averaged 102 - 103 mm in the Keogh River (de Hrussocozy-Wirth 1979), 74-100 mm in the Cowichan-Koksilah system (Argue **et al,** 1979), 103 mm in Salwein Creek (Schubert 1984) and 93-98 mm in the Salmon River (Schubert 1982), a lower Fraser tributary draining the watershed located adjacent to the Campbell River watershed. It is hypothesized that the large smolt size reflects lower rearing densities which may have occurred during 1981 as a result of high egg mortalities during the December 26, 1980 floods.

Disease Monitoring : Results from the 'fog-eye' assessment are detailed in Table 3. A definite opacity of the lens was noted in 70.9% of the individuals held 0-16 hours after capture, declining to 14.0% and 18.1% in individuals held up to 40 and 72 hours respectively. The incidence declined in all categories between 16 and 40 hours, while the incidence of severe cases increased between the 40 and 72 hour groups. Although the above data were not collected in a vigorously controlled manner, a number of preliminary conclusions can be drawn:

1. Stresses associated with the fence trapping technique produce a high incidence of 'fog-eye' in coho smolts.

2. Opacity of the lens appears to be related primarily to the initial stress of capture; recovery was quite rapid, even under the secondary holding stress.

3. When the secondary stress persists, the condition is aggrevated in the more susceptible individuals and incidence of severe, and possibly irreversible, cases increase. This suggests that, in order to minimize potentially irreversible effects, smolts should not be held more than four days prior to tagging and, if possible, should be tagged and released within one day.

Chinook Smolts

Age and size data for chinook smolts is inconclusive because the fish were not identified to species in the field; consequently, only 0+ fish were identified. The overall fork length averaged 86.1 mm (Table 2), with the larger individuals captured later in the sample period (Appendix 3b).

Table 3. Incidence and severity of 'fog-eye' in relation to holding time (initial figure is number observed, bracketed figure is percent).

MAXIMUM HOLDING TIME (hours)	Condition Code*				
	0	1	2	3	4
16	58 (29.1)	61 (30.7)	51 (25.6)	17 (8.5)	12 (6.0)
40	172 (86.0)	21 (10.5)	3 (1.5)	4 (2.0)	0 (0)
72	167 (81.9)	18 (8.8)	6 (2.9)	11 (5.4)	2 (1.0)

*Condition Codes: 0 - no fog-eye observed; 1 - slight fog-eye in one eye; 2 - slight fog-eye in both eyes; 3 - severe fog-eye in one eye; 4 - severe fog-eye in both eyes

Trout Smolts

All trout sampling was conducted by Fish and Wildlife Branch personnel. Data is on file at the Fisheries Research Section, Fraser Valley Hatchery (R. Land, pers. comm.).

CONCLUSIONS

1. A major objective of the 1982 study was to assess the ability of the Semiahmoo Fish and Game Club members to conduct similar programs in the future. The performance of the SFGC volunteers involved in this study indicates that such projects are within the capabilities of the club providing two conditions are met: First, that the Department of Fisheries and Oceans provide adequate technical support for the more specialzed activities such as coded wire tagging. Second, that a more permanent, low maintenance downstream trap is constructed at the site.

   Toward fulfillment of the second condition, the SFGC began construction in 1983 (in conjunction with Fish and Wildlife Branch personnel) on a semipermanent downstream trap similar in design to the trap currently in use on the Keogh River (de Hrussoczy-Wirth 1979). This trap requires minimal maintenance under normal flows and can accomodate peak flows of up to 5.7-8.5 cms (P.Slaney, pers. comm.). This range encompasses all but the largest storm events in the system (Appendix 6).

2. A number of factors make the Campbell River suitable for intensive study: First, it is a productive stream which is morphologically typical of a number of streams in the Fraser Valley and on the east coast of Vancouver Island. Second, study assessment is facilitated by the prior existance of an adequate upstream/downstream trapping facility. And finally, costs can be minimized by involving SFGC volunteers.

3. A potentially serious problem of residualization of cultured steelhead smolts was identified in 1982. Fish and Wildlife Branch personnel are currently formulating strategies intended to reduce this problem; however, in view of the potential impact of reared smolts on coho fry, it is recommended that a cooperative program be developed to assess and minimize the impact through predation of hatchery releases on wild stocks.

SUMMARY

1. A 'W' converging throat weir was operated in the Campbell River during the period April 27 through June 22, 1982 as part of a coho smolt coded wire tagging study designed to investigate the fishery contribution, migratory pattern and survival rate of that stock. Catches totalled 16,138 coho smolts, 229 chinook smolts, 1,012 wild steelhead smolts, 232 cutthroat smolts and 267 chum fry.

2. A total of 15,637 coho smolts were released with adipose clips and coded wire tags (02 22 62). Delayed tag loss averaged 3.88% and post tagging mortality was negligible.

3. 'Fog-eye' was the most prevalent anomaly encountered in the coho smolts, effecting 8.0% of those examined. A brief assessment of 'fog-eye' suggested that the highest incidence resulted from capture stress and was quickly reversible, and that the incidence of severe and possibly irreversible cases increased with time retained in holding pens.

4. A total of 1433 of the 4000 cultured steelhead planted in Campbell River on April 30 were recaptured at the fence. When the capture efficiency of the fence is considered, an estimated 50% to 64% of the planted smolts did not leave the stream within 51 days of release. Given the potentially detrimental interaction of these fish with wild stocks, a thorough reexaminiation of the steelhead smolt outplant strategy is indicated.

5. Approximately 99.9% of the coho smolt population was composed of 1+ individuals, the remainder being two year olds. Overall, coho smolts averaged 112.9 mm in length and weighed 13.3 g.

6. Coho smolts were captured primarily during a four week period beginning in early May, with the 50% peak occurring in mid-May.

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Appendices

APPENDIX 1(A). DAILY FENCE TRAP CATCHES IN CAMPBELL RIVER.

DATE	COHO SMOLTS	CHINOOK SMOLTS	CHUM FRY	HATCHERY STHD		WILD STHD		CUTTHROAT		KELTS		LAMPREYS				PRICKLY SCULPINS	STICKLEBACK	CRAYFISH	LONGNOSE SUCKER
				SMOLTS	PRE-SM	SMOLTS	PRE-SM	SMOLTS	PRE-SM	STHD	CTT	PAC.	BROOK	RIVER	AMOCOE				
APR 28	1	0	0	0	0	1	0	0	0	0	0	2	0	0	0	0	1	0	0
29	227	0	0	0	0	9	0	1	0	0	3	1	0	0	0	5	0	0	0
30	256	0	1	0	0	13	0	5	0	0	0	0	0	0	0	2	3	0	0
MAY 1	353	0	3	56	0	12	0	5	0	0	1	2	0	0	0	10	0	0	0
2	130	0	1	3	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0
3	283	0	2	145	1	17	0	2	0	0	0	2	0	0	0	0	0	0	0
4	178	0	4	57	0	6	0	3	0	0	0	0	0	0	0	8	0	0	0
5	405	0	1	125	1	16	2	0	0	0	0	0	0	0	0	2	0	0	0
6	322	0	0	26	0	12	1	1	0	0	0	1	0	0	0	6	0	0	0
7	617	0	1	76	0	14	4	5	3	0	0	0	0	0	0	1	0	1	0
8	919	0	9	137	0	76	0	7	0	0	0	0	0	0	0	4	0	0	0
9	857	0	9	75	0	45	0	7	0	0	0	0	0	0	0	6	0	1	0
10	942	0	5	62	0	39	1	5	2	0	0	0	0	0	0	7	0	3	0
11	864	0	13	50	0	45	1	12	3	1	0	0	0	0	0	0	0	4	0
12	1109	0	9	80	0	60	4	5	3	1	1	0	0	0	0	6	0	2	0
13	712	0	10	39	0	74	2	3	2	0	0	0	0	0	0	3	0	0	1
14	419	0	5	58	0	90	1	6	0	0	0	1	2	0	0	14	0	1	0
15	736	0	15	104	0	129	0	6	0	0	5	0	0	0	0	5	1	2	0
16	728	0	4	64	0	59	0	7	0	0	1	0	0	0	0	3	0	1	0
17	387	0	3	30	1	40	2	9	2	0	0	2	0	0	0	10	0	1	0
18	878	0	26	25	0	23	4	4	0	0	0	0	1	0	0	6	0	9	0
19	1187	0	20	66	0	74	3	16	0	0	1	1	0	0	0	11	0	5	0
20	681	0	6	22	0	16	1	11	0	0	0	1	1	0	0	8	0	4	0
21	455	0	0	22	0	18	1	5	0	0	1	1	0	0	0	10	1	7	0
22	244	0	1	8	0	24	9	6	0	0	0	0	1	0	0	4	0	11	0
23	400	0	11	16	0	16	4	9	0	0	0	1	0	0	0	8	1	10	0
24	359	0	11	9	0	16	2	11	1	0	0	0	2	0	0	15	0	3	0
25	167	0	1	9	0	9	2	4	0	0	0	0	0	0	1	10	0	16	0
26	149	0	4	5	0	8	2	5	2	0	0	0	2	0	0	4	0	8	0
27	104	0	1	1	0	2	1	5	0	0	0	0	1	0	0	5	0	9	0
28	203	0	0	7	1	11	4	15	1	0	0	0	0	0	0	8	0	11	0
29	148	27	3	10	0	10	6	10	0	0	0	0	1	0	0	6	0	9	0
30	144	26	6	6	0	10	4	7	1	0	0	0	1	1	0	7	0	4	0
31	152	28	5	9	0	1	5	5	0	0	0	1	1	0	0	17	0	10	0
JUN 1	121	22	7	6	0	8	12	4	0	0	0	0	0	1	0	7	0	16	0
2	95	17	8	0	0	1	8	2	0	0	0	0	1	0	0	8	0	1	0
3	81	15	7	2	0	0	6	3	1	0	0	0	1	0	0	13	0	8	0
4	29	5	10	1	0	0	4	3	0	0	0	0	1	0	0	12	0	7	0

CONTINUED

APPENDIX 1(A). DAILY FENCE TRAP CATCHES IN CAMPBELL RIVER.

DATE	COHO SMOLTS	CHINOOK SMOLTS	CHUM FRY	HATCHERY STHD		WILD STHD		CUTTHROAT		KELTS		LAMPREYS				PRICKLY SCULPINS	STICKLEBACK	CRAYFISH	LONGNOSE SUCKER
				SMOLTS	PRE-SM	SMOLTS	PRE-SM	SMOLTS	PRE-SM	STHD	CTT	PAC.	BROOK	RIVER	AMOCOE				
5	13	17	4	0	0	1	1	3	0	0	0	0	0	0	0	11	0	6	0
6	6	8	0	2	0	2	0	2	0	0	1	0	0	0	0	7	0	6	0
7	11	15	1	0	0	0	2	1	0	0	0	0	0	0	0	9	0	7	0
8	9	11	6	2	0	2	2	4	1	0	0	0	0	0	0	19	0	8	0
9	0	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	3	0
10	5	7	7	2	0	0	2	3	0	2	0	0	0	0	0	13	0	22	0
11	13	0	3	4	0	0	2	0	0	0	0	0	0	0	0	11	1	13	0
12	9	7	3	3	0	0	0	3	0	0	0	0	0	0	0	13	0	15	0
13	3	3	2	2	0	0	0	1	0	0	0	0	0	0	0	7	0	12	0
14	4	3	4	1	0	1	5	0	0	0	0	0	0	0	0	5	0	10	0
15	2	2	2	0	0	0	2	0	0	0	0	0	0	0	1	3	0	9	0
16	6	5	4	0	0	0	0	0	0	0	0	0	0	0	0	5	0	6	0
17	5	4	2	2	0	0	0	1	0	0	0	0	0	0	0	1	1	10	0
18	0	0	2	0	0	0	0	0	0	0	0	0	0	0	0	7	1	6	0
20	3	0	0	0	0	1	0	0	0	1	0	0	0	0	0	13	0	8	0
22	7	0	5	0	0	0	1	0	0	0	0	0	0	0	0	7	0	11	0
TOTAL	16138	229	267	1429	4	1012	114	232	22	5	14	16	16	1	2	383	6	320	1

PRE-SM = PRESMOLT
STHD = STEELHEAD TROUT
CCT = CUTTHROAT TROUT
PAC = PACIFIC
BROOK = WESTERN BROOK
AMOCOE = AMOCOETE

APPENDII 1(B). MORNING AND AFTERNOON FENCE TRAP CATCHES IN CAMPBELL RIVER.

DATE	COHO SMOLTS		CHUM FRY		STEELHEAD SMOLTS HATCHERY		STEELHEAD SMOLTS WILD		CUTTHROAT SMOLTS	
	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY	NIGHT	DAY
APR 28	1	0	0	0	0	0	1	0	0	0
29	227	0	0	0	0	0	9	0	1	0
30	255	1	1	0	0	0	13	0	5	0
MAY 3	283	0	2	0	144	1	17	0	2	0
4	178	0	4	0	57	0	6	0	3	0
5	405	0	1	0	125	0	16	0	0	0
6	320	2	0	0	26	0	12	0	1	0
7	537	80	1	0	76	0	14	0	5	0
10	657	285	5	0	62	0	36	3	5	0
11	755	109	13	0	50	0	40	5	12	0
12	1109	0	9	0	79	1	60	0	5	0
13	712	0	10	0	39	0	74	0	3	0
14	249	170	3	2	54	4	78	12	6	0
15	680	56	15	0	96	8	114	15	5	1
16	600	128	4	0	46	18	37	22	7	0
18	496	382	22	4	25	0	22	1	4	0
19	1168	19	18	2	66	0	74	0	16	0
25	167	0	1	0	9	0	9	0	4	0
26	149	0	4	0	5	0	8	0	5	0
27	104	0	1	0	1	0	2	0	5	0
31	152	0	5	0	9	0	1	0	5	0
TOTAL	9204	1232	119	8	969	32	643	58	99	1

NOTE - 'NIGHT' DENOTES THE CAPTURE PERIOD 1600 TO 0900; 'DAY' DENOTES THE CAPTURE PERIOD 0900 TO 1600.

APPENDIX 2(A). 1982 CAMPBELL RIVER COHO SMOLT TAGGING RESULTS (CODE 02 22 62).

TAGGING DATE	MAXIMUM HOLDING TIME (DAYS)	PRE-TAGGING MORTALITY	RELEASED WITHOUT TAGGING	TOTAL NUMBER MARKED	48 HOUR REJECT RATE		TOTAL MARKED AND WITHOUT TAGS		POST TAGGING MORTALITY		TOTAL RELEASED WITH TAGS
					#N	%	ADIPOSE ONLY	###TAG LOST	IMMEDIATE	####48 HOUR	
MAY 4	5	3	9	1453	452	5.97	4	60	0	0	1389
7	3	5	12	1345	218	##2.29	1	26	0	0	1318
11	4	4	42	3543	299	0.67	0	22	0	0	3521
13	2	5	17	1741	190	0.53	4	9	0	0	1728
17	4	3	24	2229	224	##0.45	0	9	0	0	2220
20	3	4	27	2729	274	1.46	0	36	0	0	2693
25	5	3	28	1578	155	1.29	0	18	0	0	1560
31	6	5	19	940	168	##7.74	4	60	0	0	876
JUN 7	7	2	17	365	366	9.84	0	31	0	2	332
TOTAL	-	34	195	15923	2346	3.88	13	271	0	2	15637

SAMPLE SIZE HELD TO ASSESS TAG LOSS.
HELD FOR 24 HOURS ONLY.
###BASED ON % REJECT RATE APPLIED TO ENTIRE TAG LOT.
####BASED ON MORTALITY RATE OBSERVED IN QCD SUBSAMPLE EXPANDED TO ENTIRE TAG LOT.

APPENDIX 2(B). INCIDENCE OF ANOMALIES ENCOUNTERED WHILE TAGGING CAMPBELL RIVER COHO SMOLTS DURING 1982 (SECOND FIGURE INDICATES A SEVERE ANOMALY WHICH WAS RELEASED UNTAGGED).

DATE	NUMBER INSPECTED	FOG EYE	NESCUS	EXOP-THALMIA	FIN EROSION	SCHOLI-OSIS	LORDOSIS	OPERC-ULUM DAMAGE	SCALE LOSS	GENERAL DAMAGE	NATUR-ALLY MISSING ADIPOSE
MAY 4	1465	26/1	17/0	6/5	1/0	-	-	1/0	5/0	1/3	-
7	1362	17/0	14/0	2/10	1/0	-	1/0	-	3/0	0/2	-
11	3589	196/13	43/0	3/22	3/1	-	-	2/0	9/2	1/4	1
13	1763	313/0	25/0	0/11	0/1	0/1	-	2/0	6/0	3/4	-
17	2256	210/0	21/0	0/10	4/0	-	0/2	-	14/4	0/8	-
20	2760	417/0	43/0	3/12	8/1	-	1/2	2/0	17/0	1/12	-
25	1609	49/0	16/0	2/17	3/1	-	-	2/0	11/3	1/7	-
31	964	38/0	4/0	1/7	2/2	-	1/1	-	1/2	0/7	1
JUN 7	384	8/0	2/0	3/4	1/0	-	0/2	-	1/3	2/8	-
TOTAL	16152	1274/14	185/0	20/98	23/6	0/1	3/7	9/0	67/14	9/55	2
% TOTAL	-	7.97	1.15	0.73	0.18	0.01	0.06	0.06	0.50	0.40	0.01

APPENDIX 3(A). 1982 CAMPBELL RIVER COHO SMOLT LENGTH-FREQUENCY DISTRIBUTION.

WEEK ENDING:	APRIL 30			MAY 7			MAY 14			MAY 21			MAY 28			JUNE 4		
AGE:	1+	2+	TOTAL	1+	2+	TOTAL	1+	2+	TOTAL	1+	2+	TOTAL	1+	2+	TOTAL	1+	2+	TOTAL
FORK LENGTH (MM)																		
70-74	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
75-79	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
80-84	-	-	-	-	-	-	-	-	-	-	-	-	1	-	1	-	-	-
85-89	-	-	-	-	-	-	-	-	1	-	-	-	3	-	3	1	-	1
90-94	-	-	-	-	-	2	-	-	1	6	-	6	5	-	6	5	-	5
95-99	-	-	-	-	-	-	2	-	3	11	-	13	12	1	14	15	-	16
100-104	-	-	-	-	-	2	6	-	8	8	-	10	18	-	20	5	-	5
105-109	-	-	-	1	-	5	13	-	18	15	-	17	10	-	10	5	-	5
110-114	-	-	2	2	-	5	19	-	23	12	-	13	9	-	9	19	-	20
115-119	1	-	6	4	-	15	9	-	13	15	-	16	17	-	19	14	-	14
120-124	1	-	4	4	-	12	11	-	15	13	-	14	7	-	7	9	-	9
125-129	-	-	6	2	-	5	11	-	12	5	-	5	3	-	3	5	-	5
130-134	7	-	14	-	-	2	1	-	1	6	-	6	3	-	3	4	-	4
135-139	4	-	10	-	-	-	1	-	1	-	-	-	1	-	1	1	-	1
140-144	-	-	1	-	-	2	2	-	2	-	-	-	-	-	-	-	-	-
145-149	-	-	4	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
150-154	2	-	2	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
155-159	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
160-164	-	-	1	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
SAMPLE SIZE	15	0	50	13	0	50	75	0	98	91	0	100	89	1	96	83	0	85
% TOTAL	100	0	-	100	0	-	100	0	-	100	0	-	98.9	1.1	-	100	0	
MEAN LENGTH	134.7	-	131.6	118.5	-	114.7	115.7	-	114.5	111.4	-	111.1	108.4	95.0	108.0	110.6	-	110.5
STANDARD DEV.	9.21	-	9.93	5.72	-	8.19	9.72	-	9.92	10.8	-	10.7	11.68	-	11.64	11.71	-	11.64
MEAN WEIGHT (G)	-	-	16.5	-	-	15.3	-	-	13.3	-	-	13.1	-	-	13.0	-	-	12.5
SAMPLE SIZE	-	-	50	-	-	17	-	-	33	-	-	35	-	-	42	-	-	46

CONTINUED

APPENDIX 3(A). 1982 CAMPBELL RIVER COHO SMOLT LENGTH-FREQUENCY DISTRIBUTION CONT'D.

WEEK ENDING:	JUNE 11			JUNE 18			TOTAL		
AGE:	1+	2+	TOTAL	1+	2+	TOTAL	1+	2+	TOTAL
FORK LENGTH (MM)									
70-74	-	-	-	-	-	-	0	0	0
75-79	1	-	1	-	-	-	1	0	1
80-84	-	-	-	1	-	1	2	0	2
85-89	-	-	-	3	-	4	7	0	9
90-94	3	-	4	6	-	7	25	0	31
95-99	4	-	4	2	-	3	46	1	53
100-104	2	-	2	2	-	3	41	0	50
105-109	3	-	3	4	-	4	51	0	62
110-114	5	-	6	3	-	3	69	0	81
115-119	3	-	3	1	-	1	64	0	87
120-124	1	-	1	1	-	1	47	0	63
125-129	-	-	-	-	-	1	26	0	37
130-134	-	-	-	1	-	1	22	0	31
135-139	-	-	-	-	-	-	7	0	13
140-144	-	-	-	-	-	-	2	0	5
145-149	-	-	-	-	-	-	0	0	4
150-154	-	-	-	-	-	-	2	0	2
155-159	-	-	-	-	-	-	0	0	0
160-164	-	-	-	-	-	-	0	0	1
SAMPLE SIZE	22	0	24	24	0	29	412	1	532
% TOTAL	100	0	-	100	0	-	99.76	0.24	-
MEAN LENGTH	104.7	-	104.4	101.6	-	101.5	111.5	95.0	112.5
STANDARD DEV.	10.86	-	10.82	12.42	-	12.47	12.35	-	12.78
MEAN WEIGHT (G)	-	-	13.0	-	-	8.8	-	-	13.3
SAMPLE SIZE	-	-	23	-	-	37	-	-	283

APPENDIX 3(B). 1982 CAMPBELL RIVER CHINOOK SMOLT LENGTH-FREQUENCY DISTRIBUTION, FOR AGED SAMPLES ONLY.

WEEK ENDING:	JUNE 4	JUNE 11	JUNE 18	TOTAL
AGE:	0+	0+	0+	0+
FORK LENGTH (MM)				
70-74	1	-	-	1
75-79	8	2	1	11
80-84	4	4	5	13
85-89	1	4	12	17
90-94	1	6	9	16
95-99	-	-	2	2
100-104	-	1	2	3
105-109	-	-	-	-
110-114	-	-	-	-
115-119	-	-	-	-
120-124	-	-	-	-
125-129	-	-	-	-
130-134	-	-	-	-
135-139	-	-	-	-
140-144	-	-	-	-
145-149	-	-	-	-
150-154	-	-	-	-
155-159	-	-	-	-
160-164	-	-	-	-
SAMPLE SIZE	15	17	31	63
MEAN LENGTH	79.9	86.7	88.8	86.1
STANDARD DEV.	5.55	6.78	5.4	6.9

APPENDIX 4. 1982 DAILY WATER TEMPERATURES, AIR TEMPERATURES AND WATER LEVELS IN CAMPBELL RIVER.

DATE	TIME (H)	TEMPERATURE		WATER LEVEL (M)	DATE	TIME (H)	TEMPERATURE		WATER LEVEL (M)
		WATER (C)	AIR (C)				WATER (C)	AIR (C)	
APR 28	1030	10.00	10.00	-	MAY 19	1600	14.00	18.50	.054
	1500	12.50	11.50	-	20	0800	11.00	12.00	.052
29	0900	9.50	7.50	-		1430	14.00	16.00	.052
	1700	12.00	11.00	-	21	0800	11.00	13.00	.052
30	0815	8.50	7.50	-	22	0900	12.00	10.00	.051
	1630	12.00	11.50	-	23	0900	11.00	13.00	.05
MAY 1	1000	10.00	11.00	-	24	1045	11.80	12.00	.05
2	1100	10.50	9.50	-	25	0800	12.20	13.60	.048
3	0820	8.50	7.50	-		1600	14.00	16.50	.048
	1730	12.00	11.00	-	26	0800	11.00	13.20	.048
4	0800	8.50	8.00	-		1500	14.00	16.00	.048
5	0830	9.00	8.50	-	27	0800	11.80	13.00	.05
	1530	12.50	11.00	.058		1500	13.50	16.50	.05
6	0830	10.50	11.00	.056	28	0900	12.80	13.00	.049
	1530	13.50	20.50	.056	29	0930	12.00	15.00	.047
7	1000	12.00	9.00	.056	30	0930	12.00	14.20	.048
	1300	13.25	N/R	.056	31	0830	13.30	14.50	.047
8	0900	10.50	9.50	.058		1545	15.00	N/R	N/R
9	0900	10.50	11.00	N/R	JUN 1	0800	13.20	11.50	.045
10	0800	10.60	11.00	.054	2	0800	12.00	10.50	.045
11	0800	11.00	11.00	.054	3	0800	12.00	11.00	
	1400	13.00	N/R	.054	4	0800	12.00	12.20	.045
12	0800	11.00	11.00	.054	5	1015	12.00	10.50	.045
	1600	12.00	17.00	.054	6	1430	14.00	11.00	.045
13	0800	11.00	12.00	.054	7	0800	10.50	11.00	.045
	1600	13.00	14.00	.053	8	0800	12.00	13.00	.044
14	0900	11.00	11.00	.056	9	0800	11.00	11.80	.044
	1500	12.00	14.00	.059	10	0815	12.80	13.00	.043
15	0730	11.00	10.00	.057	11	0830	13.00	13.20	.043
	2000	14.00	16.00	.055	12	1130	15.00	18.00	.044
16	0700	11.00	9.50	.053	13	0900	14.00	13.00	.044
	1530	14.00	18.50	.052	14	0815	13.00	14.00	.044
17	0800	12.00	11.00	.056	15	0830	13.00	12.20	.043
18	0800	11.00	9.00	.058	16	0800	14.00	15.20	.044
	1600	13.00	16.50	.057	17	0745	14.00	14.50	.043
19	0800	11.00	10.00	.054	18	0800	14.20	17.00	.042

APPENDIX 5. SUMMARY OF CAMPBELL RIVER SALMON ESCAPEMENTS. NOTE: EXCEPT WHERE NOTED, DATA ARE FROM DEPARTMENTAL ESCAPEMENT FILES (BC-16).

YEAR	COHO	CHUM	CHINOOK	YEAR	COHO	CHUM	CHINOOK
1947	1500	200	-	1969	200	25	-
1948	750	200	-	1970	750	200	-
1949	400	750	-	1971	750	200	-
1950	750	750	-	1972	7500	400	-
1951	3500	750	-	1973	3500	200	-
1952	1500	1500	-	1974	3500	250	-
1953	1500	1500	-	1975	2200	400	-
1954	750	0	-	1976	3500	200	-
1955	400	200	-	1976‡	500	200	-
1956	750	200	-	1978‡	1500	50	25
1957	400	75	-	1979	1500	75	25
1958	400	75	-	1980‡‡	2500	200	30
1959	750	25	-	1981‡‡	1900	149	112
1960	400	75	-	1982‡‡	3087	205	75
1961	400	75	-				
1962	200	25	-	AVERAGE			
1963	400	25	-	-------			
1964	750	75	-	51-60	1035	440	-
1965	200	25	-	61-70	370	53	-
1966	400	75	-	71-80	2695	218	27
1967	200	0	-	78-82	2097	136	53
1968	200	0	-				

‡ FROM SCHUBERT (1982).
‡‡ BASED ON SFGC FENCE COUNTS.

APPENDIX 6. MEAN DAILY DISCHARGE (CUBIC METERS/SECOND) BY MONTH FOR CAMPBELL RIVER. (STN. 08MH059, LOCATED APPROXIMATELY 4 KM FROM THE MOUTH)

YEAR	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	ANNUAL EXTREME	
													MAX	MIN
1961	-	-	-	-	0.92	0.29	0.20	0.13	0.15	0.32	0.88	1.92	-	-
1962	1.85	0.99	1.03	0.84	0.61	0.23	0.10	0.15	0.11	0.28	1.01	1.38	3.77	0.04
1963	1.65	1.85	1.04	1.28	0.71	0.24	0.29	0.22	0.14	0.22	2.34	4.01	14.20	0.09
1964	2.97	1.14	2.16	0.99	0.48	0.23	0.18	0.06	0.23	-	-	-	-	-
MEAN	2.16	1.33	1.41	1.04	0.68	0.25	0.19	0.14	0.16	0.27	1.41	2.44	-	-

POOR

QUALITY

ORIGINAL